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PROVISIONAL APPLICATION FOR PATENT COVER SHEET

This is a request for filing a PROVISIONAL APPLICATION FOR PATENT under 37 CFR 1.53(c).

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Respectfully submitted,

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SURFACE AND TRANSDUCER SYSTEM

Overview

The enclosed patent disclosure is for a powering and digital communication surface that operates with multiple cord free smart digital transducers such as pens, cursors, pucks and pawns operating with a generic position-resolving tablet. Therefore, it is not a tablet patent, but a surface and transducer system that operates in conjunction with a tablet.

A number of new high-level features and functions are provided:

1. The ability to receive, store, transport and transmit digital data from one system to another. Can pick up a file at home with your pen, put it into your pocket, and carry it to work to use.

2. The ability to transmit a stored signature or ID that can be compared to your signature written at the time - for ID and security purposes.

3. The ability to transmit a stored authorization code that allows you access to a confidential file or to approve something.

4. The ability to use active and passive elements on a surface in order to create a graphic rendition such as a landscape or a schematic. Can have pawns represent trees or logic elements that you can move around in order to locate.

5. The ability to power and operate pens, mice, pucks, pawns, and other implements on a surface with a wide range of keypads, indicators, sensors, displays and lights.

Salient features and functions include the following:

1. The use of resonance circuits in the surface to transmit power using current multiplication for increased efficiency and higher received transducer voltage levels – particularly useful in portable applications.

2. The ability to operate with multiple "smart" digital transducers operating simultaneously using different communication formats and modes optimized for each type of transducer – using digital means not analog such as frequency separation etc.

3. The use of pulse width and encoded digital communication for addressing, synchronization and data communication – in contrast to prior analog based designs using analog means such as frequency shift etc.

4. The use of pressure sensor circuitry in the pen that while under the control of a controller or microprocessor, directly creates a communication output that is not limited in resolution by the controlling logic.

5. The ability to provide entirely new features, for example, such as a smart transducer or pen that can send a stored signature or ID to the surface for authorization or receive data that can be transported and communicated to another surface system.

6. The ability to operate simultaneously with numerous pawns or other transducers on the surface for an entirely new form of graphic and creative functionality such as landscape or circuit layout.

From a technical viewpoint it appears, when compared to prior art, that it is useful to have the following design differentiation:

1 To have the surface grid pattern and circuitry used to transmit power and information, not resolve position and be entirely independent of the tablet position-resolving system except for it to output a received pen or other transducer signal (putting it into a unique category compared to most prior art).

2 To have the powering grid not be a single coil that surrounds the entire table area (prior art covers this specific configuration although the coil is not resonant).

3 To have the transmit powering grid be required in one direction only (since in most prior art both directions are required since it is part of the position resolving system). However, if desired, grids in both X and Y direction can be used to speed up the system operation.

4 To have the powering grid be at a 45-degree angle to the perpendicular direction grids (since technically only one grid direction is needed to power the pen and in prior art the X and Y directions are required).

5 To have the powering grid be a tuned resonant circuit with the advantage of much higher transmitted power, less drive current etc. for portable unit use (compared to prior art where they are not tuned and require higher drive current for a given amount of powering or signal transmission).

6 To have the surface powering and signal resonant circuits be opened or shorted to prevent secondary radiation into the position-resolving grid (further differentiates the design compared to prior art).

7 To have the powering grid not be switched or connected per sa but that the power source be turned on or off and with the drive circuitry

not be used for signal receiving purposes (prior art often uses common switches between the powering and position resolving grid).

8 That the positioning resolving or table grid can be a higher impendence than the powering grid (since in some prior art the same grid is used for both purposes and, therefore, the entire grid must be low impendence, and therefore, cannot be located on top of a display).

9 To specifically cover moving or static cursor, pucks, pawns and other transducers in addition to pens (prior art often covers pens only).

10 That the design only transmits a magnetic field to the transducer with minimum electric and/or radio components (prior art often mixes up magnetic, electromagnetic, electric and radio fields or defines the wrong dominant domain).

11 That the powering system not be for the direct or specific purpose of resolving just pen switch or pressure status but a wide range of functions such as communicating digital data (compared to prior art that is very specific)

12 That the transmitted power not be directly reradiated back for pen status and position purposes but instead is transmitted by an active oscillator (in much prior art the residual signal of the powering signal is used for these purposes).

13 That the tuned circuit in the pen tuning not be changed in tuning even if the transmitted signal may change slightly in frequency be modulated or otherwise modified to indicate switch or pressure status (in prior art the tuning is changed).

14 That the pen use amplitude or on/off pulse width and digital or encoded transmission of pen switch and pressure status (prior art often uses phase or frequency shift).

15 That the pen be a "digital" pen with all sorts of new capabilities such as ID, signature, approval codes, security encrypting, etc. – call it a

"digital pen" (compared to prior art that is analog without digital capability).

16 That the system be able to resolve the position of multiple transducers and multiple circuits such as resolving the angular rotation of a cursor having two tuned circuits for determining direction (prior art is generally limited to one transducer and one coil).

17 That the powering signal creates power in the pen or transducer only and is not directly used for pen status or positioning purposes (prior art does use diodes to convert AC signal to DC but sometimes for different purposes).

18 That the tuned circuit used to receive power be able to operate with a separate tuned circuit used for position purposes as well as the same common tuned circuit (compared to some prior art where they must be the same)

19 Where the transmission of pen pressure is not dependent on the resolution of the control circuitry (compared to prior art where the resolution is limited by the speed and resolution of the logic or processor).

Surface And Cordless Transducer Patent Disclosure
FinePoint Innovations
Confidential

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Abstract

Disclosed herein is a smart surface that can stand-alone or be contained within a portable computer or other system, for powering and communicating with single or multiple cord-free transducers. Operating or charging power is transmitted by the surface using a carrier signal that is on/off keyed or amplitude modulated with synchronization, clock, enable, address, modes, commands and other pulse width, encoded or digital data. The signal is transmitted to single or multiple cordless smart transducers located on or above the surface, such as pens with multiple pressure sensing and switch capability, pointers, stylus, cursors, pucks, mouse, pawns, implements and similar items. Overlapping resonant inductive circuits are used in the surface, which requires less power to create an electromagnetic field of a given strength, through the process of current multiplication, which in turn transmits operating power and communicates data to the transducer(s). The transducer(s) are smart or intelligent in that they contain digital circuitry, such as a processor or controller, that can be used to decode, interpret and operate on the power and information received from the surface, including encrypted data for security if desired, and when the surface is not transmitting, they generate and transmit response signals back to the surface. Enabled when the surface is not transmitting, the transducer(s) transmit an analog on/off keyed or modulated signal having ID, status, and other data, with or without security encryption, to a internally contained tablet or digitizer that detects and outputs the data to the surface controller, processor or to a host compute, and then independently determines their coordinate location. Example uses included a stored signature file or ID code in a pen that is transmitted to the surface, for the purpose of comparing it, using an associated computer, with current writing on the surface for security or access purposes, or for having a transducer receive

a data file from one surface that then is transported to another surface and it's associated host system.

Field of Invention

The present invention relates to a transducer powering, communication and position resolving smart surface that transmits operating power that is encoded with address, instructions, modes, commands, synchronization and other data, to single or multiple cordless transducers, such as a pressure sensitive pen, located on or above the surface. Transducer(s), such as a pen, when enabled, transmit back to the surface encoded analog signals that can be used by an enclosed tablet for determining coordinate location and for outputting receiving ID, status and other digital data to the surface controller, processor or host computer. This invention does not define the table coordinate position resolving means or methods.

SUMMARY OF THE INVENTION

Objectives

Accordingly, a first and primary objective of this invention is to efficiently provide, in a powering, communication and position-resolving surface using resonant circuits or coils, minimum input power to transmit sufficient power or energy to simultaneously operate a number of cordless moveable smart transducer(s), such as a pressure-sensitive pen, on or above the surface. It is a second objective to provide a capability of transmitting a wide range of analog

and digital status and other information to and from the transducer(s), based on their individual characteristics and requirements. It is a third objective to perform these functions in operation with the use of a independent or generic tablet within the surface to in order to determine the transducer(s) position with immunity to noise and interference. It is a forth objective to be compatible with operation with a portable computer, PDA, terminal or other device or system that may have a display, lighting and other components within close proximity of the surface.

Functions

The enclosed system, in operation with position resolving or tablet capability, serves the purpose of electronically reproducing pen handwriting, printing, sketching, drawing, menu and item selection as well as providing for the transmission from the pen or other transducer stored signatures or codes that can be compared with current writing, writing pressure or system codes for security and authorization purposes. Conversely, the surface can transmit digital data and information to the pen or receive data and information from the pen for other purposes. For example, if the pen receives information from one surface and is transported to another surface, the pen can then transfer or send the information to the other surface and associated computer system. This allows a convenient and rapid means of transferring a file from one system to another.

A number of pawns or other locating devices can be employed to represent graphic items such as trees, bushes or other items in a landscape drawing or rendition as the pawns can be moved around as a means to determined their optimum location. Alternatively, pawns or other items can be assigned as schematic symbols or numerous other items as a means to construct schematics, graphic or other position based information. If desired for some applications, the information and data transmitted to and received from the transducer or pen or can be encrypted for security purposes.

OVERALL SYSTEM OPERATION

The overall system consists of a surface having a transmit power or charging and data signal capability, a transducer or pen for receiving the power and data and, in response, for transmitting back a position resolving signal and data such as pressure or switch status, and a tablet that resolves the transducer position from the signal and, in operation with the system, outputs the received data from the pen or other transducer for detection and processing by the system. Covered herein are the methods and means of sending power and data from the surface to a transducer or multiple transducers, the transducer operation, and the methods and means of detecting and decoding the signal and data received back from the transducer. The tablet coordinate position resolving capability utilizes an available or generic surface grid and surface system design who's detail design and methods for resolving coordinate position, are not covered by this effort except as a system component. The pressure sensor used in a pen or other transducer is also of a generic design where the detail design and methods are also not covered by this effort except as a stand-alone system component.

The enclosed system operates with a number of transducers including pens, pointers, cursors, pucks, mice, pawns, implements and similar items. However, each of these devices has unique requirements and needs. For example, a pen used for handwriting must operate at fast or high-slew speeds with minimum static, dynamic, impulse, pen down and tilt errors in order to be able to accurately reproduce handwriting – the handwriting being electronically resolved using a tablet by determining the pen position coordinates as it moves on the surface.

In a pen, the power and communication electromagnetic coil circuits have a very small diameter in order to fit within the pen dimensions, and as result, it has a small amount of magnetic coupling with the surface and, therefore, receives and transmits very low power. On the other hand, cursors, pucks, mouse, pawn and other implements do not need to move at such high speeds, do not have an angular or tilt error since they lay flat on the surface, and the transmit and

receive circuit(s) often can be a much larger diameter for increased coupling with the surface, and as a result, the can receive and send much higher power or signals.

Therefore, it is advantageous to have adaptable communication formats that transmit to and receive back data and information from each transducer based on its individual characteristics or status. Normally only one "fast' handwriting pen is used on the surface at one time, wherein, a number of "slow' moving pawns maybe be used simultaneously. The pen, since it has less power, may need to employee extremely low-power control circuitry or low-speed processor, wherein; a larger pawn or other device may inherently have greater power available, allowing higher speed processing.

For the pen with reduced power it is necessary to have lower-speed circuit with resulting simpler address, enable or other commands that it can discern, however, the pawn or other device with higher power maybe to handle higher speed and more complex data and information. However, these properties are consistent with having perhaps one "fast" pen on the surface and a dozen "slow" pawns, wherein, the higher number of pawns means they need more complex communication to address or identify them than is necessary with a single pen. Therefore, multiple communication formats are defined herein to meet these varied requirements

Surface Operation

As shown in the Surface Block Diagram, the surface contains a series of overlapping transmit resonant inductive based coils or loops, that when enabled by self-resonance, or driven by an external AC signal source, individually or in a pattern, creates a radiating electromagnetic field that powers or charges the transducer(s) in a manner having increased voltage amplitude over non-resonant methods. The surface transmit power, using a powering analog carrier signal that is on/off and/or amplitude modulated to represent pulse width, pulse position or a encoded digital pattern that, in turn, is used to power and to address, enable, synchronize, control, or otherwise send data or other information to the transducer. Less power is required in the surface because

of the properties of current multiplication associated with resonance. A microprocessor, controller or computer controls, enables and modulates the transmit power and data signal in accordance with defined modes of operation and communication formats.

It is not necessary that the transmit grid be in both X and Y directions as only one direction is required. In addition, a single grid can be placed an angle such as 45 degrees relative to X and Y directions. This is because the transmit grid has no position resolving functions but only serves to transmit power and data to the transducer or pen. However, for faster speed of operation it is possible to utilize both X and Y directions and then only resolve the transducer or pen position within close range of the transmit signal. This will reduce the number of receive coils or grids that need to be read for data and increase the rate of operation. However, the position is totally resolved by the tablet not the transmit function.

Surface Signal Sources

In one embodiment, as shown in the Surface Block Diagram, a stable signal source provides a square wave, sine wave, triangle wave of other similar waveform to drive the loops in the surface. The resonant characteristics of the transmit loops on the surface convert the waveform to a substantially sinusoidal form. The source can be derived from a sources such as a processor clock and divided down as required to an appropriate operating frequency or can come directly from a crystal or resonator based oscillator. The signal source can be gated off, along with the grid loops, if desired when signals are being received from a transducer in order to minimize background noise and interference in the tablet receiving coil pickups and circuitry. The signal from one the above described signal sources are then gated to the appropriate surface loop, generally one at a time, under control of a processor and program.

Since the surface coils or loops are resonant, they do not turn off quickly. Therefore, it necessary to squelch or short them out in order to stop the signal transmission in a rapid fashion. Otherwise, the transmission signal will be artificially lengthened and will turn off slowly,

making its detection more difficult in the transducer. This is accomplished by means of a shorting transistor or circuit that shorts out the turned circuit under processor or controller control at the end of a transmission. The same circuit used to provide the drive signal can also serve to short out the resonant coils or it can be a separate circuit.

The drive can be serial where the grid resonant circuit is a low-impedance drive that drives a series resonant circuit where the resulting drive signal developed across the coil is much higher than the drive signal. Alternatively, the drive can be higher impedance parallel drive circuit output that is directly driven or transformed by an impedance matching capacitor to parallel resonate coil circuits. In the tablet, since the grid does not have to be low-impendence to provide driving power, and if transparent grid material such as tin oxide is utilized, the grid can be placed on the top of a display for closer proximity to the pen or other transducer.

Surface Current Multiplication

The operation and efficiently of the resonant surface coils compared to non-resonant circuits are substantial. In the case of the resonant circuit, energy is transferred back and forth between an inductor (in this case a coil loop or loops on the surface) and a capacitor(s)). Once resonance is achieved, it is only necessary to provide additional current to account for losses in the circuit caused by the equivalent series resistance in the circuit. The amount of current multiplication can be defined by the Q or quality quotient of the circuit that is defined as the ratio of the impedance of the inductance divided by the value of the equivalent series resistance (XL/Rs).

The equivalent series resistant value includes all the resistance in the circuit including the actual coil series resistance, a resistor added to intentionally reduced Q, parallel resistance, loading caused by the transducer(s) on the surface, the dielectric characteristics of surrounding material, shielding of the magnetic field caused by metallic surfaces in close proximity and other environmental factors. The higher the Q the higher the resonant current that can also be called

current multiplication - the multiplication of the current beyond what the current would be if their were no resonance.

However, it is important to understand that the current is increased and the resulting magnetic field is increased a proportional amount by the use of resonance. However, the laws of conservation dictate that you cannot transmit more power and the transducers cannot receive more power than is actually supplied to the surface resonant circuits minus all losses. In this case, the transducers are very loosely magnetically coupled or otherwise have a low-coupling coefficient so they don't significantly load down the surface circuits, otherwise, they don't increase the series resistance of the transmit resonant circuit(s) and reduce the Q significantly.

The overall result is that the signal voltage level of the receiving transducer is substantially increased by the current multiplication of the transmitting resonant circuit even while its actual power receiving capability is not. However, having a high voltage level in the transducer, while requiring less power to operate the surface is a major advantage, particularly in portable applications, such as when the surface is contained within a portable computer, PDA, terminal or other battery operated device. The voltage level in the transducer reaches sufficient levels that it allows the operation of very low-power digital logic and processor circuit.

Surface Transmit Coil Patterns

The surface consists of overlapping parallel coils or loops in the X or Y direction of the position resolving area of the surface. Parallel transmit coils can be utilized in the X direction only, in the Y direction only or in a direction that is at a 45% degree angle to the X and Y directions. Additionally, coil can be used in multiple directions if they are not operated at the same time. In a common embodiment, the parallel wires of each side of one coil are roughly about 2 inch apart in the direction that coils are placed. One coil is then overlapped by another parallel coil roughly 30 to 50%, wherein; a coil overlapped by 50% has one side of a parallel coil or coils in its center.

These number can vary substantially even beyond the numbers provided based on the height of the transducers above the coils, the diameter of the transducer tuned circuit and other factors.

Surface Receive Tablet

The surface also contains a tablet receive grid that employs non-resonant coils or loops in the X and Y direction. The table employed is generic or non-specific in nature and the means that it employs to resolve the transducer or pen position is beyond the scope of this disclosure. However, it is assumed to have a grid, coil or wire pattern used for position determination that also can be used to pickup the transmitted digital and other information for use in surface receive operation. The surface transmit coils are independent of the receive tablet coils and are not utilized for position resolving. The same coils used for determining the transducer coordinate position are also used to receive and detect transducer status and data transmissions. Received signals are amplified, detected and converted to digital data that then is processed by a microprocessor, controller or computer. In a common tablet configuration, the surface received signal is filtered, amplified, detected and converted to a DC voltage that is proportional to the received signal amplitude.

An effective method to convert the AC signal to a DC voltage is the use of an integrator where during the time the transducer signal is being received, where the integrator, starting from a zero voltage, is allowed to charge to a level that is representative of the signal amplitude. A small signal results in a charge to a low voltage level and a large signal results in a charge to a high voltage level in a proportional amount.

During the time the transducer signal stops and the surface is transmitting the integrator charge is changed in polarity and a fixed reference discharge voltage is implemented. The time that it takes for the integrator to discharge back to zero is then proportional to the amplitude of the transducer signal that charged the integrator. This time or period is measured, the received transducer signal amplitude calculated, and from the amplitude of the signals received by

multiple tablet loops in the surface, and the coordinate position can be determined. In addition, the tablet circuitry can receive amplitude modulation and convert it to digital data in order to resolve transducer status and other digital data. As has been previously discussed in reviewing prior art it is not necessary that the transmitted signal from the transducer be continuous since the integrating conversion process does not require a signal during the period the reference signal is used for discharge.

The position resolving circuitry can operate on the signal for a period such as 250 microseconds, providing time for the received signal to full reach its maximum value and then stop reading the signal before it turns off for either logic condition. The means the position resolving circuitry is not affected by the variable length of the transmission as long as the transmission exceeds a minimum length. On the other hand, status or data resolving circuitry can determine the length or the presence or absence of signal at the end of the period in order to determine the logic status of the transmission.

Transducer Or Pen Operation

When enabled and/or on/off modulated, resonant transmission loops or coils within the surface transmits power or a charging signal, using an electromagnetic medium having a carrier operating at about 470 KHz, in a typical configuration, as well as on/off modulated with synchronization, enable, address, control, instruction and other information to one or a multitude of transducers or pens. Before the initial surface transmission begins, or if the pen is out of operating range or proximity of the surface, the pen is not powered, is not enabled, and does not actively operate or transmit a signal.

The transducer or pen has as a transceiver tuned resonant inductive or coil circuit, that is initially passive, and when activated upon receipt of a surface power or charging signal, resonates, and in operation with two diode rectifiers and a storage capacitor or filter, creates DC operating power.

Upon transmission from the surface of an initial power and a synchronization or sync signal, the transducer or pen, if within range or proximity, charges up with operating power.

If the power and sync signal is of the proper amplitude, as determined by adequate power to operate the pen circuitry, and a threshold or sync detector that determines that the signal has reached a minimum threshold level, that represents a logic 1, and if the period of the sync pulse length before it goes off, that represents a logic 0, is within a predetermined period, including a tolerance for uncertainty, then a processor or controller enables the pen for further operation.

After the surface transmission sync signal stops, and after a small delay, the pen transmits back to the surface an electromagnetic response signal, using the same transceiver tuned resonant inductive circuit used to receive power and signals from the surface, that is enabled and/or on/off modulated, to operate as an active self-resonant oscillator or transmitter source to the surface. Alternatively, the circuit to transmit a signal used to can be a separate circuit from that used to receive the powering signal from the surface and it can be driven by an external signal source or oscillator that can be used in a similar manner, under pressure or digital control, to transmit a position resolving signal, ID, status, received signal level or other data to receive coils in the surface.

The pen or other transducer signal is used to detect the coordinate X and Y direction position relative to a tablet contained within the surface, and it communicate status such pen tip pressure, side-switch, or other data or information.

Transducer Coil Configurations

The larger diameter and sometime closer proximity of the coil with the surface of a cursor or similar larger diameter transducer, and the resulting greater electromagnetic coupling with the surface, means that it can receive excess signal and act as a excess load if not compensated for this property. Therefore, large diameter transducers, compared to smaller diameter transducers

such as a pen, maybe implemented with different configurations or embodiments. For example, in a pen it is a common practice to tap off the end(s) of a tuned circuit in order to achieve as high a powering voltage as possible. However, in order to do this it is also necessary to dramatically minimize the current drain of the pen in order to not load the tuned circuit excessively.

In the case of a cursor, puck or similar device, the power tap off the tuned circuit can be made at other than the coil end points, for example, halfway between the end points and ground reference. This is because excess input voltage maybe is available and, therefore, a lower tap position can be used to provide sufficient voltage and to the enclosed circuitry. In the case of the tap at a halfway point, the load on the overall tuned circuit is reduced by a ratio of 4 to 1. This means the cursor is less of a load to the powering surface and/or more power is available to operate circuitry in the cursor, compared to a pen. In some cases, it is possible to make the power receiving circuitry un-tuned or non-resonant and receive sufficient voltage and power.

Additional Methods To Minimize Transducer Power Loading

While the load of a transducer such as a cursor can be kept to a minimum the digital control of transducers on the surface means that only one at a time is enabled to be utilized or communicated with. The one exception to this is the pen or pointer stylus that is generally allowed to operate at all times in order to maintain high operating speed, to minimize communication needs since it has less operating power and needs to employ lower speed processing, since only one such writing device is used on the surface at a time. The surface sends out address and enable commands that turn on other appropriate transducer individually since they maybe used in significant numbers on the surface. Therefore, the overall power loading on the surface of multiple large diameter transducers is further reduced since they are enabled to transmit only one at a time.

TRANSDUCER DETAILED DESCRIPTION

PEN TRANSDUCERS

The pen is implemented in standard and high-performance versions or embodiments that both have a pressure sensing tip and a side switch capability. The high-performance version contains a 16-bit microprocessor that allows advanced features such data storage and security encryption, a multi-transducer mode (allowing more than one pen to be active on the tablet at a given time), and additional multiple pressure or other sensing elements within the pen, such as pressure-sensing side-switches or an eraser.

MOUSE, PAWN, PUCKS, IMPLEMENTS AND OTHER TRANSDUCERS

Other transducers such as a mouse, pawn, puck and other transducer are configured and operate in the same manner as the high-performance pen. However, they maybe equipped with a keypad, visual and other indicators, additional switches or pressure sensors, and multiple tuned circuits that can be used to determine their position as well as angular direction. In addition, they maybe equipped with a higher-speed processor, expanded memory, expanded address capability and other features and capabilities since they generally have a larger coils and can receive more operating power. Otherwise, their operation is identical to that described below for the high-performance pen with additional modes and operating commands.

PEN AND OTHER TRANSDUCERS THEORY OF OPERATION

The pen or other transducers receives a powering or charging and synchronizing or **"Sync"** signal via a set of loops within the surface grid. The standard pen, high-performance pens and other transducers use the length of this sync signal to decode the information being conveyed by the tablet. The pen or other transducers then communicates the required responding information by time keying or on/or modulating the pen or other transducer transmit drive signal.

In normal operation, the pen or other transducer is in a **"Standby Mode"**, in that it does not normally transmit any signals when it is awaiting a command from the tablet. This allows the transceiver coil in the pen or other transducer to detect the incoming signal. While the **"Sync"** signal is present, the transceiver coil absorbs the resonant charging energy and causes the transceiver tuned circuit in the pen or other transducer to resonate.

The pen or other transducer has as a transceiver tuned resonant inductive or coil circuit, that is initially passive, and when activated upon receipt of a surface power or charging signal, resonates, and in operation with two diode rectifiers and a storage capacitor or filter, creates DC operating power. Upon transmission from the surface of an initial power and a synchronization or sync signal, the pen or other transducer, if within range or proximity **(Prox is On),** charges up with operating power.

If the power and **Sync** signal is of the proper amplitude, as determined by adequate power to operate the pen or other transducer circuitry, and a threshold detector that determines that the signal has reached a minimum threshold level, that represents a logic 1, and if the period of the sync pulse length before it goes off, that represents a logic 0, is within a predetermined period, including a tolerance for uncertainty, then a processor or controller enables the pen or other transducer for further operation.

After the surface transmission **Sync** signal stops, and after a small delay, the pen transmits back to the surface an electromagnetic response signal, using the same transceiver tuned inductive resonant inductive circuit used to receive power and signals from the surface, that is enabled and/or on/off modulated, to operate as an active self-resonant oscillator or transmitter source to the surface. Alternatively, the circuit to transmit a signal used to can be a separate circuit from that used to receive the powering signal from the surface and it can be driven by an external signal source or oscillator that can be used in a similar manner, under pressure or digital control, to transmit a position resolving signal, ID, status, received signal level or other data to receive coils in the surface.

The pen or other transducer signal is used to detect the pen or other transducer coordinate X and Y direction position relative to a tablet contained within the surface, and it also communicate status such pen tip pressure, side-switch, keypad, or other data or information. An example of the power or charging and sync signal is shown in Figure 1 below:

An example of the tablet's transmitted signal and pens or other transducer's received "**Sync**" signal is shown below in figure 1:

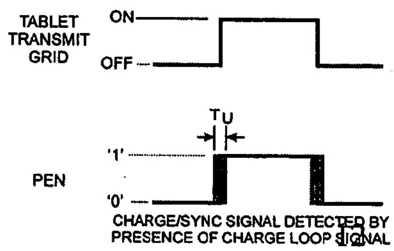


Figure 1a.

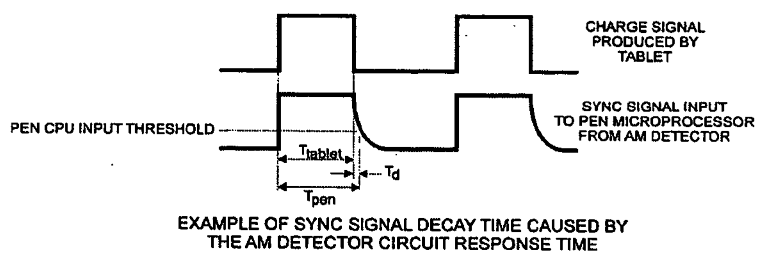


Figure 1b.

As seen in figure 1a, the **Sync** signal is in a binary '1' state during the presence of the charging signal, and a '0' state when the charging loop is off. Due to the clock rate of the microprocessor in the high-performance pen, there will be an uncertainty period (Tu) of approximately 15 μs when locking onto the **Sync** signal. By designing the valid sync pulse lengths to be much greater than the uncertainty period, this effect is minimized and will not cause any performance issues in the pen. In Figure 1b, it can be seen that the duration of the sync pulse received by the pens or other transducer's microprocessor is actually stretched. For any sync pulse emitted by the surfaces transmitting grid, the pen or other transducer sees an added duration Td of approximately 12 μs. All timing parameters referred to in this specification refer to the time **Tpen** as seen by the pen's or other transducer's microprocessor.

I. SYNC PULSE SIGNAL TIMING

The Sync pulse signal uses two timing conditions for the standard pen and three timing conditions for the high-performance pen or other transducer, to enter information into the pen. The timing conditions can be expanded for other transducers but operate in the same or similar manner.

A) CLOCK DATA

Consists of a single **Sync** pulse with duration of 325 μs.

In the standard pen, it is used to instruct the pen to transmit pressure data and the state of the side-switch.

In the high-performance pen or other transducers, it is used to clock binary data out of the pen one bit per **CLOCK DATA** pulse. Once all the data is clocked out of the pen or other transducer, further clock pulses will force the pen to transmit binary '0's

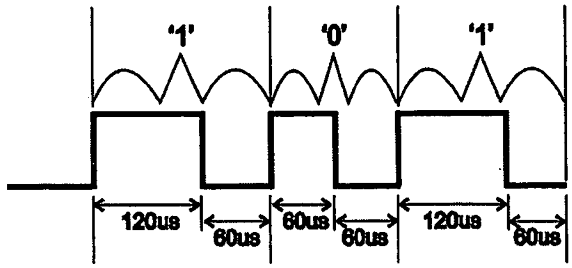
B) MODE SELECT

Consists of a series of 6 **Sync** pulses whose high-time determines the binary state for each pulse (see figure 2 below), and there must be a 60μs gap between each sync pulse.

It is used only in the high-performance pen or other transducers.

The **Sync** pulses are used to configure or request specific information from the high-performance pen.

The operating modes for the pen will be discussed with details in the "HIGH-PERFORMANCE PEN COMMAND MODE TYPES" and "PEN OPERATING MODES" sections.



EXAMPLE OF 3 SYNC PULSES FORMING A '101' PATTERN AS PART OF A MODE SELECT COMMAND

Figure 2.

C) LOAD DATA

This is a single Sync pulse with duration of 440 μs.

It is used only in the high-performance pen to:

1. Instruct the pen to reset the binary data byte being transmitted from the pen to the surface.

2. Prompt the pen to transmit pressure (if enabled).

3. Enter a new command mode (if any) into the pen - the pen then executes the new command mode following the completion of the current LOAD DATA pulse.

II. HIGH-PERFORMANCE PEN OR OTHER TRANSDUCERS MODE COMMANDS

Used only in the high-performance pen or other transducers.

The mode commands are sent by the surface to configure or setup the pen or other transducers.

The pen or other transducer is placed in a power-up default mode whenever it first comes into tablet proximity.

The setup commands sent to the high-performance pen or other transducers are broken into 3 different mode commands, as follows

1. **'11xxx' is the Enable Command.** It is transmitted to every pen or other transducer in proximity of the tablet. Pen or other transducers located in proximity with matching 3-bit IDs will be enabled and will respond to all future communications while all other transducers will be in a standby mode.

2. **'10xxx' is the Disable command.** It is transmitted to every pen or other transducer in proximity of the tablet. The pen located in proximity with a matching 3-bit ID will be disabled and will ignore all future communications until an enable command with a matching 3-bit ID is received. The ID code can be expanded beyond 3-bits if desired for other transducers.

3. **'0xxxx' is the Mode Command.** It will place the currently-enabled pen or transducers into the mode sent with this command following the next "LOAD DATA" sync pulse. All other pens or other transducers in proximity will remain unchanged.

NOTE: Mode command '00000' is treated as meaning 'no-changes' to the current pen or other transducer mode. This was intentional because the pen or other transducer will always try to load a new command when receiving a LOAD DATA sync pulse (due to timing restrictions in the pen firmware timing).

See the next section for a list of the high performance pen or other transducers modes.

III. HIGH-PERFORMANCE PEN OR OTHER TRANSDUCERS OPERATING MODES

This section describes the different operating modes of the high-performance pen and other transducers. In some cases, the same modes used in the pen are used in other transducers dependent on how they are equipped. If they are equipped with a pressure sensor then the same pressure sensor command defined for the pen may be used.

Mode #1: Standard pressure pen (default mode)
Mode-select bits: '00001'b
Description: The pen outputs one conversion of pressure data, followed by 8 bits of binary data (one for each CLOCK DATA pulse, beginning with the least-significant-bit) as defined in the "BINARY PEN DATA FORMAT" section. After transmitting 8 bits of data the pen will transmit binary data '0's until a "LOAD DATA" pulse is sent, at which time the mode will repeat itself with a new pressure conversion and an updated 8-bits of binary data. ***During the transmission of pressure data, pen position data cannot be obtained - the length of time the pen transmits a signal (related to pressure) is insufficient for a wire conversion.*** See the "SIGNAL TIMING FOR PRESSURE PEN DATA" section for details.

Mode #2: Binary-data only
Mode-select bits: '00010'b
Description: The pen transmits 1 bit of binary data for each 'CLOCK DATA' pulse, starting with the least-significant bit. A total of 8 bits are shifted, after which binary data '0' will continue to be shifted until a "LOAD DATA" pulse is sent to the pen. This is the best mode for finding pen proximity, as every responding data bit from the pen allows a wire to be converted into position information. See the "SIGNAL TIMING FOR BINARY PEN DATA" and "BINARY PEN DATA FORMAT" sections for details.

Mode #3: Reserved
Mode-select bits: '00011'b
Description: TBD

Mode #4: Write encryption data
Mode-select bits: '00100'b + encryption data (size = TBD)
Description: Updates the encryption data contained within the pen. Each bit of the encryption data is clocked into the pen with a "CLOCK DATA" pulse. ***Note: this command only works with pens equipped with flash-memory microprocessors.***

Mode #5: Read encryption data
Mode-select bits: '00101'b

Description: Instructs the pen to transmit its encryption data. Each bit of the encryption data is clocked out of the pen with a "CLOCK DATA" pulse. ***Note: this command only works with pens equipped with flash-memory microprocessors.***

Mode #6: Future - Alternate pressure sensor single data conversion
Mode-select bits: '00110'b
Description: The pen outputs one conversion of an alternate (or secondary) pressure sensor immediately following the mode command. The pen then reverts to the previously selected mode command. ***During the transmission of pressure data, pen position data cannot be obtained - the length of time the pen transmits a signal (related to pressure) is insufficient for a wire conversion.*** See the "SIGNAL TIMING FOR PRESSURE PEN DATA" section for details.

Mode #7: Reserved
Mode-select bits: '00111'b
Description: TBD

Mode #8: Update pen ID
Mode-select bits: '01xxx'b
Description: Changes the ID of the currently selected pen to the 3-bit ID transmitted within the Mode-select bits. The pen stops responding after completion of this command until a new pen ID command is sent with the new matching ID. ***NOTE: usage of the flash-memory version of the microprocessor versus the OTP processor will determine if the pen retains this information when out of prox.***

Mode #9 through MODE #14: Reserved for additional pen or other transducers modes
Mode-select bits: '01xxx'b
Description: TBD

Mode #15: Reset pen or other transducer
Mode-select bits: '01111'b
Description: Resets the pen or other high performance transducer to its default condition.

IV. EXAMPLE HIGH-PERFORMANCE PEN OR OTHER TRANSDUCERS COMMUNICATION FORMATS

a. Example of selecting a command mode - shown below is a tablet instructing a pen or other transducer to change its ID number:

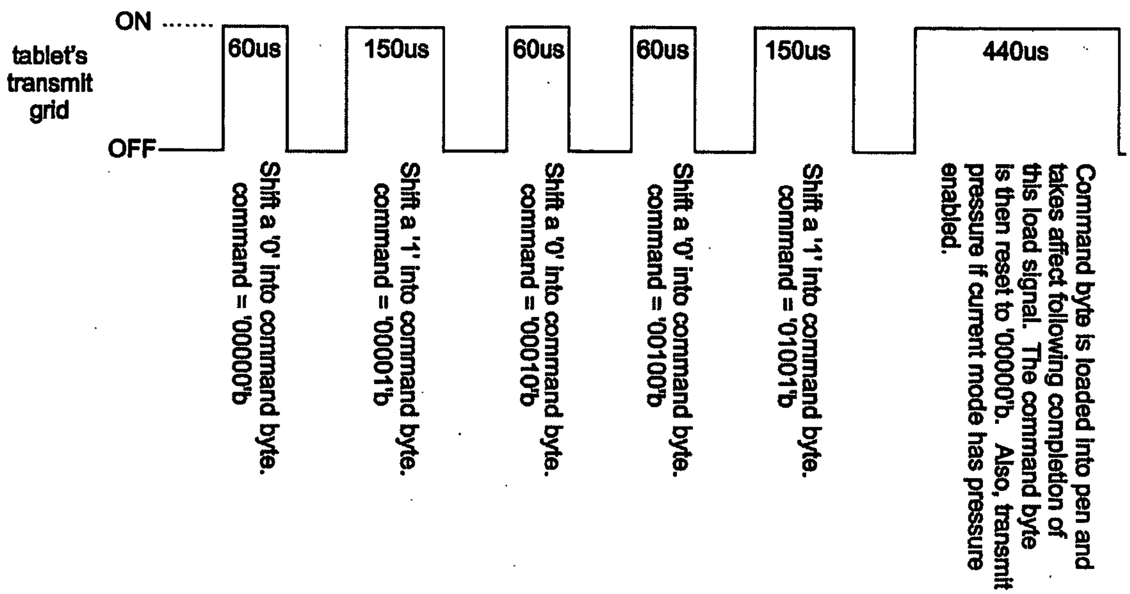
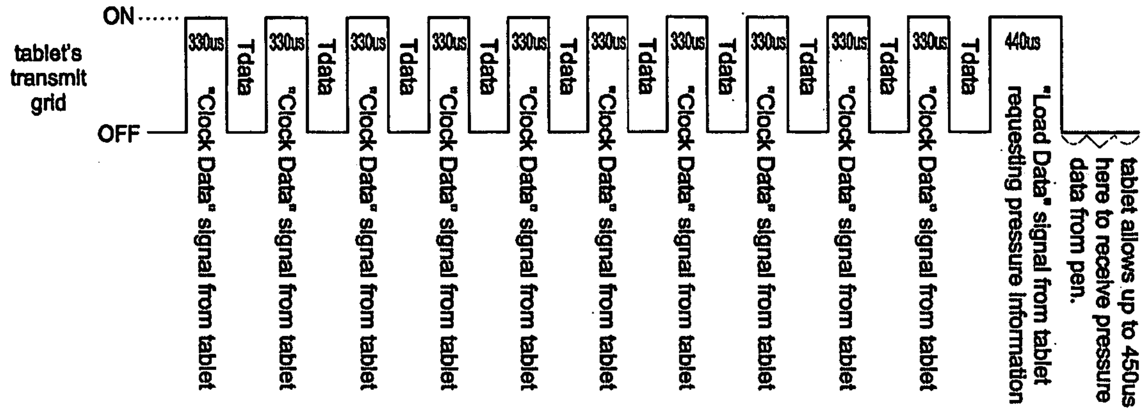


Figure 3

The currently-selected pen in **Prox** of the tablet will now only respond to the surface when the pen or other transducer ID in future commands matches the new ID of this pen or other transducer (which is now a '001'b).

b. Shown below is an example of what the surface needs to transmit to convert wire data for determining pen or other transducer position: (Reference to tablet should be Surface)



TABLET INTEGRATES A SELECTED POSITION-GRID WIRE DURING Tdata TIME

Tdata is set for 300us if the data being clocked from the pen is a binary '0' value.
Tdata is set for 340us if the data being clocked from the pen is a binary '1' value.

NOTE: The pen transmits a signal for Tdata time. The tablet must allow an additional settling time before issuing another 'Clock Data'.

Figure 4

V. SIGNAL TIMING FOR PRESSURE PEN DATA

Pressure information is clocked out of the pen or other transducer following a **"LOAD DATA"** pulse. See figure 3 and the timing table below for details. The signal length varies in proportion to the pressure – shorter when the pressure is high and longer when low.

Parameter	Definition	Min	Max	Units
Tu	**Uncertainty time from end of sync to start of pen signal**	**0**	**15**	**µs**
Tp	**Pen signal 'on' time as related to pressure:** **Minimum pressure** **Maximum pressure**	 **140**	 **420**	**µs**
Tw	**Time between Sync pulses for pressure**	**Tp + 40**		**µs**
TL	**LOAD DATA pulse width**	**438**	**448**	**µs**

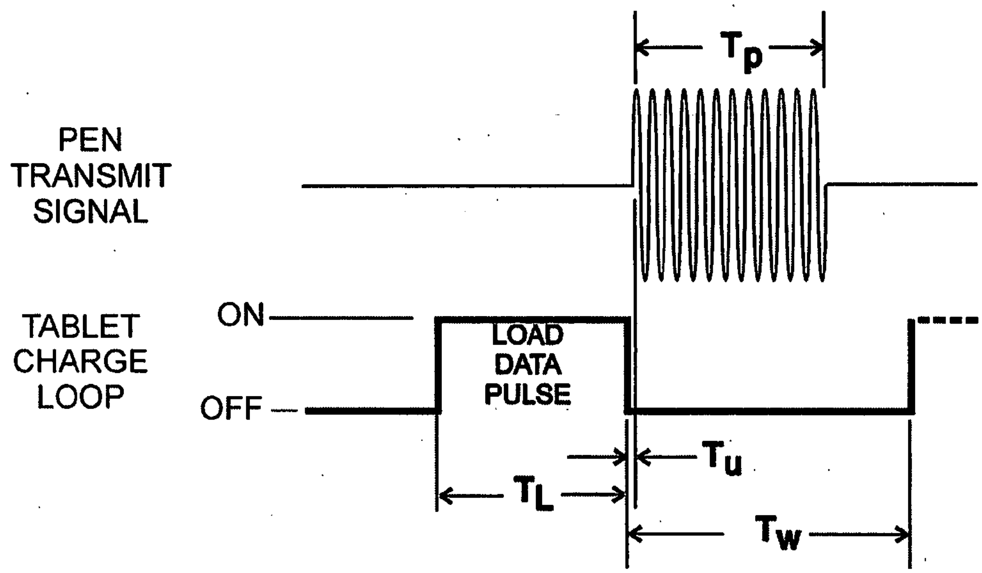


Figure 5.

Note: Tablet charge loop should be called surface transmit loops, and pen includes other transducers.

VI. SIGNAL TIMING FOR BINARY PEN OR OTHER TRANSDUCER DATA

Binary information is clocked out of the pen or other transducer following a **"CLOCK DATA"** pulse. See the timing table and Figure 4 and below:

Parameter	Definition	Min	Max	Units
Tu	**Uncertainty time from end of current sync pulse to start of pen or other transducer signal**	**0**	**15**	**µs**
To	**Pen or other transducer signal 'on' time representing binary '0'**	**300**	**300**	**µs**
T1	**Pen or other transducer signal 'on' time representing binary '1'**	**340**	**340**	**µs**
Tw	**Time between data bit clock pulses**	**To+40**	**T1+40**	**µs**

Tc	**CLOCK DATA pulse width**	**320**	**330**	**us**

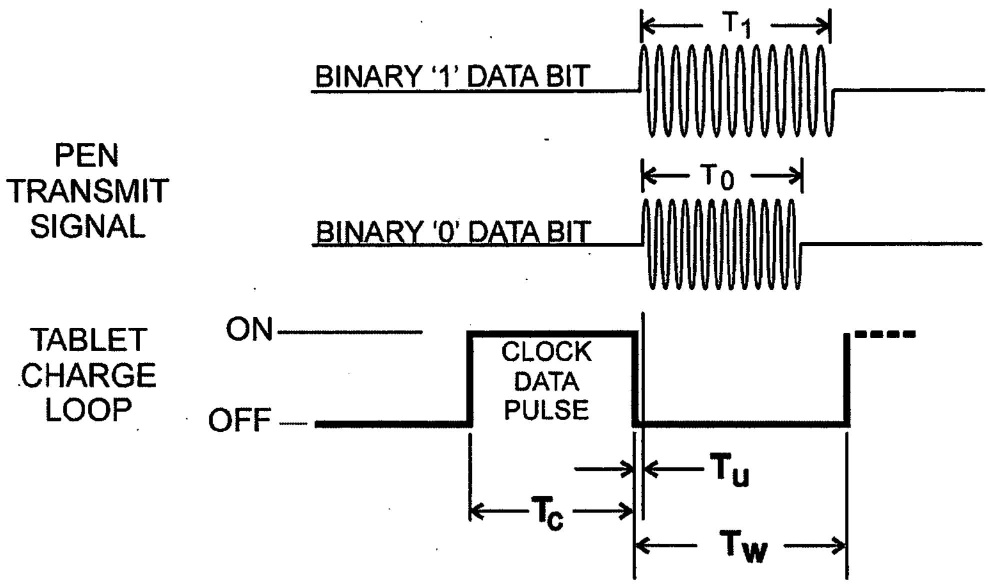


Figure 6.

Note: tablet charge loop should be surface transmit signal and pen include other transducers.

VII. BINARY PEN OR OTHER TRANSDUCER DATA FORMAT

Data is serial shifted out of the pen or other transducer at a rate of one bit per "CLOCK DATA" pulse. The order for which data is shifted is as follows:

Bit 0: Future tip-switch status.

Bit 1: Side-switch 1 status. This is a binary '1' if the switch is not pressed, '0' if pressed.

Bit 2: Future side-switch 2 status. This is a binary '1' if the switch is not pressed, '0' if pressed.

BIT 3: TBD for pen or other transducers.

BIT 4: TBD for pen or other transducers.

BIT 5-7: Pen or other transducer ID bits, where bit 7 is the MSB and bit 5 is the LSB.

CIRCUITRY DETAILED DESCRIPTION

System Overview

As shown in the **Figure 7, System Block Diagram,** the Overall System consists of the following components:

Surface Assembly
Transducer(s) Assemblies

Surface Assembly

As shown in the **Figure 8, Surface Assembly Block Diagram**, the surface assembly consists of the following:

Transmit Signal Source
Transmit Multiplexer And Squelch
Transmit Grid
Data Receive Circuitry
Control Circuitry

The surface circuitry also operates in conjunction with the following:

Tablet Circuitry (Generic)
Tablet Receive Grid (Generic)

Transmit Signal Source

The transmit signal circuitry consists of a dedicated oscillator or signal source at the operating frequency, or is a sources derived from a dedicated or shared source, such as a microprocessor clock, that operated at a another frequency, and is up or down-counted or

otherwise converted to create the desired transmit signal frequency. The transmit circuitry has a **Transmit Enable** control line that can be used by the **Control Circuitry** to turn on or turn off the signal source or its output. This allows the signal to be turned off in order to reduce background noise and interference when the transducer signal is being received by the surface. The resulting transmit output signal is the **Transmit Signal.**

Transmit Multiplexer And Squelch

The **Transmit Signal** is feed to a multiplexed that directs the signal to a specific output or address by means of a **Multiplexer Input**. Under the control of the **Control Circuitry,** the signal is feed to one of the selected **Transmit Grid Loops.** The transmit multiplexer has an **On/Off Input** that is gated by the **Control Circuitry** to modulate or turn the selected grid signal on or off. In this embodiment, the same circuitry that drives the transmit resonant coils also serves to squelch the coils in order to make them turn off in a short time.

The **Transmit Squelch** circuitry is used to squelch or dampen the resonant grid loops when and after their signal sources are turned off. Since the transmit grid loop are resonant they will continue to resonant after the **Transmit Signal** is turned off, and, therefore, will continue to transmit a decaying signal for some time. If not immediate squelched or forced to turned off, it makes it more difficult for the pen or other transducer to discern that exact time the signal is gated off, in order to measure its length or time of being on, and it adds a delay time to when the transducer or pen signal can respond by transmitting back to the surface. The Squelch circuitry consists of individual, or in an IC, bipolar transistors or FET outputs, that when enabled, serve to squelch or short out the selected transmit grid Loop under control of the Control Circuitry.

Transmit Grid

The transmit grid consists of a series of overlapping resonant loops that when a specific loop is fed a signal from the **Multiplexer,** it serves to create an electromagnetic signal at the **Transmit Signal** frequency. This signal, when on/off gated or modulated, is then the **Transmit Powering and Synchronization** signal that is sent or transmitted to the pen or other **Transducers(s).** The signal is not used to locate the transducer position

Data Receive Circuitry

The generic tablet grid and following signal amplification circuitry is used to receive transmission from the pen or other transducer for position resolving purposes. However, the same circuitry is used to receive address, control and data for use by the surface and host computer. After amplification, the received signal is received by the surface data circuitry and further amplified, filtered, detected and converted to pulse width or digital data for processing and use. As an alternative, the surface can use its own receive grid and associated circuitry to receive and process digital data received from the pen or other transducers.

Tablet

A generic magnetic based tablet design is used to independently determine or resolve the position of pens and other transducers while operating within the surface. The surface in itself does not resolve position but does power the pen or transducer and does transmit and receive digital data in operation with the pen or other transducer.

Control Circuit

The control circuitry consists of a processor, programmable logic array (PAL) or other circuitry to control the surface operation in order to transmit power, synchronization, control, address and other data to pens and other transducers and to receive back, decode and process similar data received from pens or other transducers.

Transducer Assembly

Standard or High Performance Pen Transducer(s) Assembly
Mouse, Puck, Pawn, Implements And Other Transducer Assemblies

Pen Assemblies

As shown in the **Figure 9, Battery Free Pen Block Diagram,** the pen and other transducers consist of the following.

Resonant Transceiver Resonant And Oscillator Circuit

Energy Storage

Sync/Charge Detector

Pen Control/Microprocessor

Pressure Detector

Constant Current Source

Resonant Transceiver Resonant And Oscillator Circuit

An inductor based resonant tuned circuit is employed to receive transmitted powering or charging signals from the surface that contain clocking, synchronous, address, control, commands, modes and other data or information. The pen or other transducer is initially idle, with the tuned circuit in a passive or inactive mode, awaiting reception of a signal that causes it to resonant. It is possible to have two or more tuned circuits in a transducer in order to determine its position and angular rotation.

Energy Storage

Diode and a low-pass capacitive filter convert the signal received by the tuned circuit into DC operating power to operate the pen or other transducer. The pen or transducer can charge up sufficiently with a single transmission but also can integrate the transmissions over a period. The resulting power is highly filtered by the tuned circuit and the

resulting low-pass capacitive filter, so that the quality of transmission and the occurrence of background noise or interference, such as from a display, have little impact. It is only necessary that a minimum voltage level be reached and maintained during pen or other transducer transmissions to the surface.

Sync/Charge Detector

The sync/charge detector receives and detects the presence of a received signal from the surface, and once it reaches a defined threshold level, converts it into a corresponding pulse width or digital code. The detector output then is fed to the control or processor circuitry. If a valid clock, synchronies or other control, mode, address or other data is received then the pen or other transducer responses appropriately.

Control/Microprocessor

The control circuitry or microprocessor receives and processes signals, once powered, receives and processes signals received from the surface. In response to the correct clock, signal sync, address, mode control and commands the pen responses by initiating a corresponding transmission to the surface. For example, if pressure sensor information is properly requested then it responds by transmission of the appropriate pressure sensor signal to the surface. If it receives, a mode commands then it will set its operation to match the commands and wait for further input. For example, it may receive a command to assign an address. Afterwards it will respond only to that address. Alternatively, if it receives digital data for storage in the pens or other transducer then it will respond by storing the data in memory.

Many other sensors and indicators can be connected to the control circuitry or microprocessor. For example, mouse buttons, a keypad, an indicator lamp or display, a mode button or numerous other switches or sensors for use in a mouse, pawn, puck, implement or other transducer.

Pressure Detector

A pressure sensor is used to detect pen tip pressure or other pressure sensors such as a side sensor or eraser sensor. In one embodiment, the sensor consists of a resistive element and dome assembly whose resistance goes down with pressure after reaching a certain trip level. The actual sensor method is not a part of this patent effort and other methods can be employed. The pressure is converted into a voltage level that is fed to the processor analog input port and is then used to vary the length of the pen or transducer transmit signal in proportion to the pressure - the greater the pressure the shorter the signal length. The length of the signal is then used to communicate the surface the amount of the pressure.

Constant Current Source

The constant current sources is used to provide drive current to activate and operate an active oscillator that in turn creates power in the inductive resonant tuned circuitry. Since the source provides a constant current it provides a constant transmit signal level with varying pen or other transducer power levels. Most significantly, the generated pen signal directly drives the resonance circuit so that the transmitted resolution or length of the resulting signal, operating at a high frequency, is a direct function of the oscillator and not the control circuitry or microprocessor clock speed or resolution.

Claims

1. A powering, communication and positioning apparatus, comprising a transducer and a surface,

The surface comprising a series of overlapping parallel resonant transmit coils in the X or Y or both directions or at a 45 degree angle to the X or Y direction, and

A signal source that directly drives or activates the surface coils, under processor control, one at a time, causing them to radiate an electromagnetic field with increase amplitude and,

A transducer comprising an inductive based tuned circuit that when inactive or passive receives the surface field, and

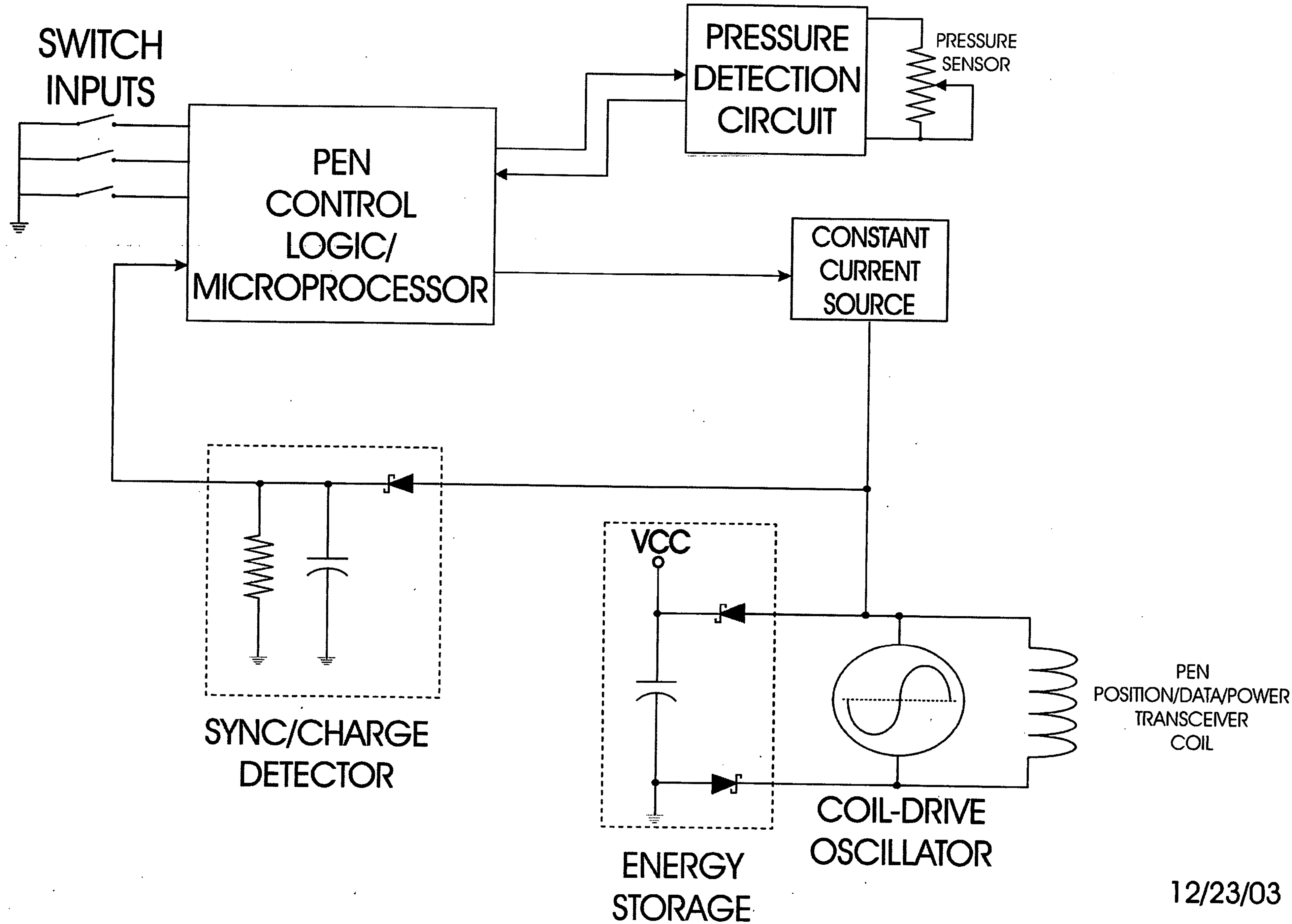
A rectifier, filter and regulator that convert the signal into a DC voltage that is used to operate circuitry in the transducer and,

The DC voltage is used to operate a processor and control circuitry that enables and on/off modulates an oscillator that activates the inductive tuned circuit that in turn creates an pulse width or encoded electromagnetic signal that is transmitted to the surface and,

The surface contains a generic tablet that independently determines the transducer position and output to the surface or host computer the received transducer signal for detection and decoding.

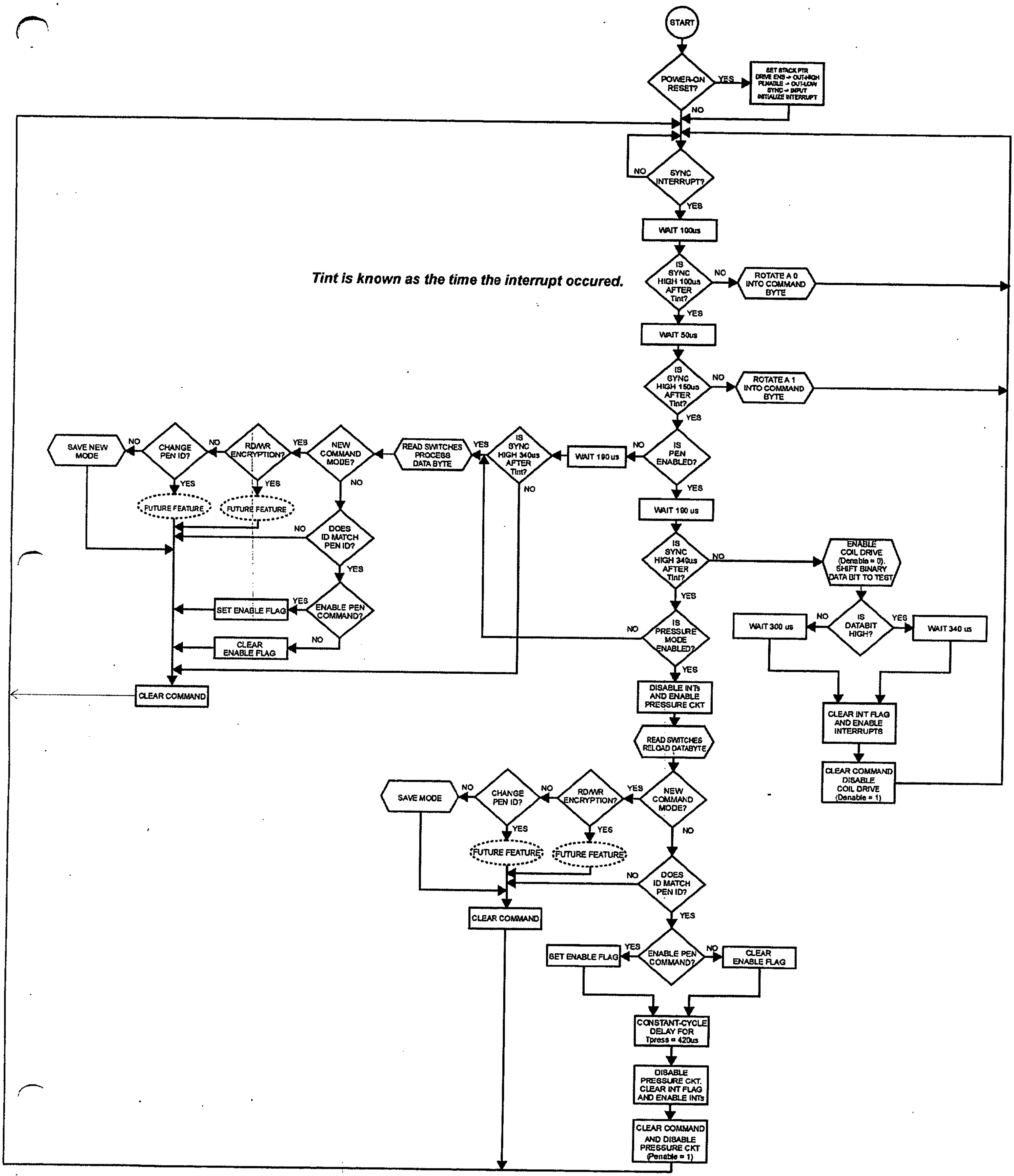
Etc.

BATTERY-FREE PEN BLOCK DIAGRAM



12/23/03

STANDARD BATTERY-FREE PRESSURE PEN FIRMWARE FLOWCHART



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